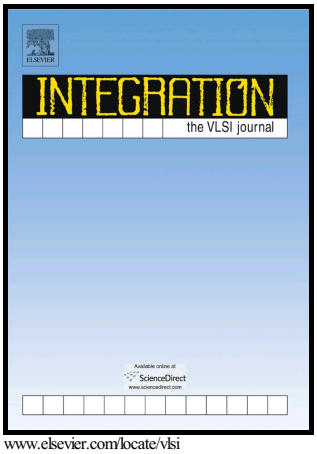
A Generalized Numerical Method for Ferrite Inductors Analysis in High Current Ripple Operation

Giulia Di Capua, Nicola Femia, Kateryna Stoyka



www.elsevier.com/locate/vlsi

PII: S0167-9260(17)30053-6
DOI: http://dx.doi.org/10.1016/j.vlsi.2017.01.008
Reference: VLSI1298

To appear in: *Integration, the VLSI Journal*

Cite this article as: Giulia Di Capua, Nicola Femia and Kateryna Stoyka, A Generalized Numerical Method for Ferrite Inductors Analysis in High Curren Ripple Operation, *Integration, the VLSI Journa* http://dx.doi.org/10.1016/j.vlsi.2017.01.008

A Generalized Numerical Method for Ferrite Inductors Analysis in High Current Ripple Operation

Giulia Di Capua, Nicola Femia, Kateryna Stoyka

Department of Information and Electrical Engineering and Applied Mathematics (DIEM), University of Salerno, Fisciano (SA), 84084, ITALY

gdicapua@unisa.it

femia@unisa.it

kstoyka@unisa.it

Abstract

Ferrite Core Power Inductors (FCPIs) operation in partial saturation offers unexplored opportunities in reducing the size of magnetic parts and the power losses in Switching Mode Power Supplies (SMPSs). This paper presents an enhanced numerical method to achieve a reliable prediction of the current ripple of FCPIs, also in partial saturation, for different conversion topologies and in whatever operating conditions. The proposed analysis includes High-Current Ripple (HCR) operations, for synchronous configurations in Continuous Conduction Mode (CCM) and for diode rectification configurations in Discontinues Conduction Mode (DCM). Relevant numerical algorithms for the reliable FCPIs current wave-shape prediction are given. Experimental verifications are performed on two boost converters in CCM and DCM to provide the validation of the proposed method.

Keywords **— Ferrite Inductors; Saturation; High Current Ripple; Continuous Conduction Mode; Discontinuous Conduction Mode; Numerical Methods; Differential Evolution; Identification Algorithms.**

NOMENCLATURE

CCM	Continuous Conduction Mode
DCM	Discontinuous Conduction Mode
V_{in}	input voltage
V_{out}	output voltage
I_{out}	output current
Q_0	converter control switch
Q_1	converter synchronous switch
D_0	converter diode
D	Q_0 duty-cycle in CCM
D_1	Q_0 duty-cycle in DCM
D_2	D_0 duty-cycle in DCM
f_s	switching frequency